MOTOROLA INC. COMMUNICATIONS DIVISION • **INSTRUCTION MANUAL**

MOTOROLA PRECISION INSTRUMENTS

Frequency Error Expander

MODEL S1061BR

PRINTED IN U. S. A.

68P81026A85-A

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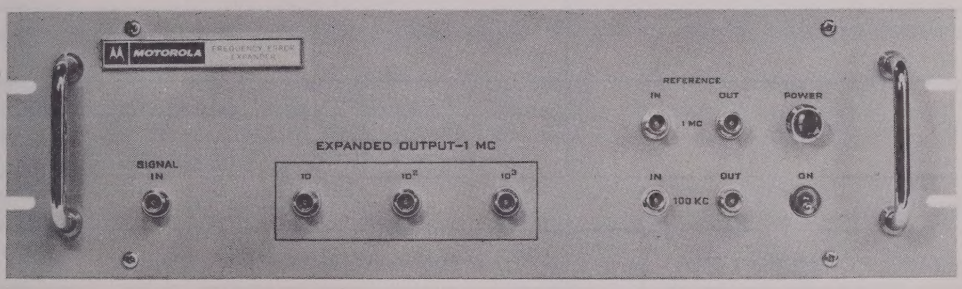
MOTOROLA

FREQUENCY ERROR EXPANDER

MODEL S1061BR

117/230 VAC



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MOTOROLA INC. Communications Division
ENGINEERING PUBLICATIONS 4501 WEST AUGUSTA BOULEVARD CHICAGO, ILLINOIS 60651

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6/25/65-UP

68P81026A85
Issue - A

GUARANTEED PERFORMANCE SPECIFICATIONS

TEST SIGNAL INPUT Frequency:	100 kc, 250 kc, 500 kc, 1 mc, 2 mc, 3 mc, 4 mc, 5 mc.
Level:	0.3 volt to 2 volts rms.
Input Impedance:	3K minimum
REFERENCE SIGNAL INPUT Frequency:	1 mc or 100 kc.
Level:	0.3 volt to 2 volts rms.
Input Impedance:	Approximately 3K.
EXPANDED OUTPUTS Frequency:	1 mc
Level:	1 volt rms into 3K.
REFERENCE OUTPUTS (FOR 1 MC REFERENCE INPUT) Frequency:	1 mc and 100 kc.
Level:	1.5 volt rms into 3K.
FREQUENCY ERROR RESOLUTION	Parts in 10^7, 10^8, 10^9, (all inputs on one second count.)
JITTER	Less than ±1 part in 10^9, in one second count.
	Less than ±1 part in 10^{10}, in 10 second count.
	Less than ±4 x 10^{11}, in 10 second count.
CONNECTORS	BNC
OPERATING TEMPERATURE	0° to 50° centigrade.
TEST SIGNAL BANDPASS	±12 kc, measured at expanded output.
POWER REQUIREMENTS	117 volt a-c ±10%, 50-60 cps 15 watts.
	230 volt a-c ±10%, 50-60 cps.
SIZE AND WEIGHT	19" x 5-1/4" x 7-3/4"
	Approximately 20 lbs.

SPECIFICATIONS SUBJECT TO CHANGE WITHOUT NOTICE

FOREWORD

CLAIM FOR DAMAGE IN SHIPMENT

If any damage to the shipping container is apparent upon receipt, the delivering driver should be requested to note such damage on all copies of the freight bill. This is for your protection should the material have sustained damage.

The equipment should be unpacked immediately, examined for damage and tested. If it fails to operate properly, or is damaged in any way, a claim should be filed with the carrier. The claim should be filed within 48 hours after receipt, if possible, or during a period not to exceed 15 days.

A full report of such damage should be obtained from the claim investigator, who will call upon you. For the purpose of this report, the shipping container and all packing materials should be retained for the investigator to examine.

The investigator's report should then be forwarded to:

Motorola Communications & Electronics, Inc.
Precision Measuring Instrument Department
916 Kilbourn Street Chicago, Illinois 60651

Include model number and serial number when referring to the instrument for any reason. Arrangements for repair or replacement will be made and you will be advised of the disposition of the instrument.

REPAIR AND/OR RECALIBRATION

If desired, the instrument may be returned to:

Motorola Communications & Electronics, Inc.
Precision Measuring Instrument Department
916 Kilbourn Street Chicago, Illinois 60651

for repair and/or calibration. Before shipping the instrument notify the Precision Measuring Instrument Department at the above address of the service required. Refer to the instrument by model number and serial number. On receipt of this information, you will be informed of shipping instructions. If requested, an estimate of the charges will be made before work begins, provided the instrument is not covered by the warranty.

SHIPPING

The instrument should be surrounded by two or three inches of excelsior or similar shock absorbing material and packed in a strong exterior container. It should be shipped via truck, railway express, air freight or air express.

WARRANTY

This equipment is guaranteed by Motorola, for a period of one year after delivery to the original purchaser, against defects in design, material, and workmanship. Our liability under this warranty is limited to servicing or adjusting any instrument returned to the factory service department for that purpose and to replace any defective parts thereof.

This warranty is effective for one year after delivery to the original purchaser when the instrument is returned, transportation charges prepaid by the original purchaser, and when upon our examination it is disclosed to our satisfaction to be defective. If the fault has been caused by misuse or abnormal conditions of operation, repairs will be billed at the net price of necessary parts and a service charge at Motorola's then prevailing labor rate. In this case, an estimate will be submitted before the work is started.

This warranty is in lieu of all other warranties, expressed or implied and all other obligations or liabilities on Motorola's part.

If any fault develops, the following steps should be taken:

1. Notify us at the following address:

Motorola Communications & Electronics, Inc.
Precision Measuring Instrument Department
916 Kilbourn Street Chicago, Illinois 60651

Give full details of the difficulty, and include model number and serial number. On receipt of this information, we will give you service data or shipping instructions.

2. On receipt of shipping instructions, forward the instrument prepaid to the preceding address or to the authorized repair station indicated on the instructions. If requested, an estimate of the charges will be made before the work begins, provided the instrument is not covered by the warranty.

EPD-12871-O

1. INTRODUCTION

The Motorola Model S1061BR Frequency Error Expander is a frequency comparator that offers the unique ability to multiply the difference between any of the signal input frequencies specified and a reference frequency allowing direct, accurate frequency comparisons to be made quickly on a digital counter in $\frac{\Delta F}{F}$. Therefore the time required to make frequency comparisons is greatly reduced when high orders of measurement resolution are required. For example, in 1 second, the measuring resolution for any of the signal input frequencies is parts in 10^9; in 10 seconds, parts in 10^{10}; in 100 seconds, parts in 10^{11}. Additional output connectors are provided for supplying 1.0 megacycle or 100 kilocycles reference (with 1 mc reference input only) to an electronic counter for gating or synchronizing.

2. SYSTEM DESCRIPTION

Circuitry of the Model S1061BR Frequency Error Expander consists of three mixer-multiplier modules, one reference module, one universal input module, all of the plug-in card type, and a power supply module rigidly mounted to the chassis. All signal connections to and from the unit are made through bnc type panel mounted connectors. Power input connections and the line fuse are accessible from the rear of the unit. The frequency error expander has no operating controls and is available for use on 117 or 230 v a-c, 50-60 cps line. Either of the line voltages may be used by making minor wiring changes as outlined in section on 117/230 V INPUT OPERATION.

3. OPERATION

There are no operational controls on the Model S1061BR Frequency Error Expander. Use of the unit is controlled solely by input and output signal connections.

a. Signal In

The unknown test frequency to be measured may be either 100 kc, 250 kc, 500 kc, 1 mc 2 mc, 3 mc, 4 mc, or 5 mc. Measuring resolution is reduced by a factor of 10 when used with a 100 kc test signal.

b. Reference In

Either 1.0 mc or 100 kc frequencies are used as the basis against which Signal In is compared.

c. Reference Out, 1 MC or 100 KC

A 1.0 mc reference frequency, or 100 kc derived from it, which may be used for gating frequency counters. With a 100 kc reference frequency, no reference output is available.

d. Expanded Output-1 MC; 10, 10^2, 10^3

The test signal (signal-in) with the frequency error resolved to parts in 10^7, 10^8, and 10^9 on a one second count. These outputs connect to the electronic counter input.

Applying the 10^3 expanded test signal to a 1 mc electronic counter, and gating the counter with 1 mc reference-out would produce measurement resolution of parts in 10^9 for 1-second counts. Since a .002 cycle difference between the reference and test a 1 mc test signal is expanded 1000 times, a 1 mc 6-digit electronic counter display would read 1.0 mc plus or minus 2 cycles, depending on the direction of error. Resolution with a 1 mc counter is, therefore, greatly enhanced. Ten second count periods by the counter will result in resolution of parts in 10^{10}. For further examples, refer to Table 1.

Operating bandwidth of the frequency error expander is ±12 kc measured at the selected expanded output. With a reference input of 1 mc (absolute) and using the 10^1 output, a one megacycle test signal input is limited to a maximum of ±1200 cps. Using the 10^2 output, test input is limited to ±120 cps, and operation from the 10^3 output, ±12 cps. When a 1 mc signal with an accuracy of ±1 x 10^{-9} is used as the reference, operation from the 10^3 output limits the input to 1 mc ±11 cps. The user is cautioned that incidental FM may deviate the test signal beyond the effective bandpass, especially if operation of the expander is from the 10^3 output. In this event, inconsistant readings will be displayed by the frequency counter employed in the test set-up.

4. CIRCUIT OPERATION

Referring to the block diagram of figure 1, the 1 megacycle reference input is applied to a

TABLE 1.

EXAMPLES OF OUTPUT VS FREQUENCY INPUTS

FREQUENCY (INPUT)	OUTPUT OF ERROR EXPANDER 10	10^2	10^3	$\frac{\Delta F}{F}$ (IN X10POS)	ABSOLUTE ERROR
100,000.01 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.01 cps
250,000.025 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.025 cps
500,000.05 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.05 cps
1,000,000.10 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.10 cps
2,000,000.20 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.20 cps
3,000,000.30 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.30 cps
4,000,000.40 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.40 cps
5,000,000.50 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.50 cps

In 10^2 position error resolution is 1×10^{-8}, similarly in the 10^3 position error resolution is 1×10^{-9}.

mixer and times 9 (X9) multiplier to produce a 900 kc output. The mixer generates a 100 kc signal with a tuned output circuit. This is multiplied nine times, to 900 kc, for use in the expanding circuits as well as being fed back to the mixer to support generation of a 100 kc difference frequency. Buffer amplifiers are employed at the input and output of the mixer to supply a gating signal to an electronic counter.

The test signal is routed to the universal input module where the signal is amplified, isolated and processed to an output frequency of 1 mc.

The universal input module will convert any one of eight standard test signals to 1.0 megacycle for processing through the frequency error expander. The eight test signals are listed in TABLE 1. Interpretation of the electronic count-

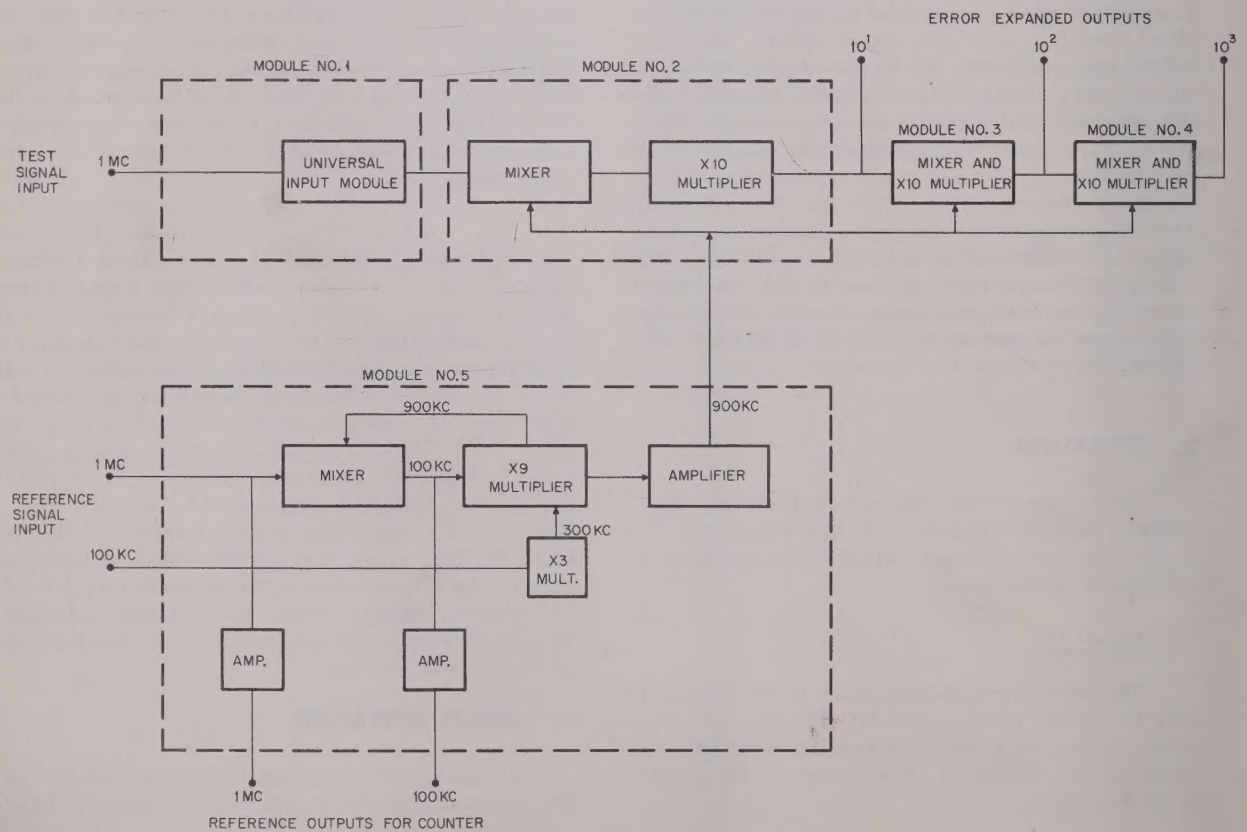

Figure 1.
Frequency Error Expander
Block Diagram

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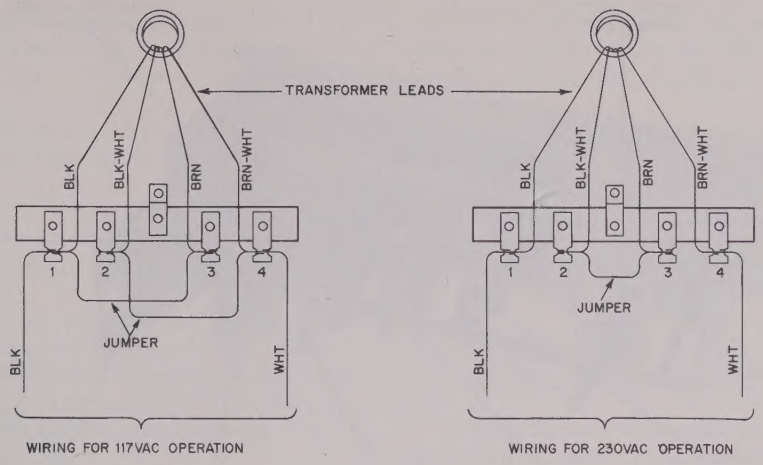


Figure 2.
117/230 V Input Connections

er presentation is also shown for each of the possible test signals.

The output of the universal input module board is mixed in module number 2 with the 900 kc synthesized from the reference module. A nominal 100 kc difference frequency is produced and multiplied ten times, producing the first expanded output, 10^1. The signal available at this point is essentially 1 mc plus or minus the error resolved to parts in 10^7.

Module numbers 3 and 4 are identical circuits to module number 2. Module number 3 combines the 1 mc, 10^1 frequency, with the 900 kc reference. The 100 kc thus generated is multiplied 10 times and yields the second expanded output, 10^2. The signal available at this point is now 1 mc plus or minus the original error resolved to parts in 10^{-8}. Module number 4 performs a similar operation, yielding an expanded output of 1 mc plus the error resolved to parts in 10^{-9}.

Essentially, the three stages of mixing and multiplying of the 1 mc test signal magnify the test signal error by a factor of 1000, maintaining the basic 1 mc around which the error exists.

5. 117/230 V INPUT OPERATION

Unless specifically stated, the unit is shipped wired for 117 v a-c operation. For 230 v a-c operation refer to figure 2.

6. ALIGNMENT PROCEDURE

a. Equipment Required

1 mc sine wave source, with a stability of at least $\pm 1 \times 10^{-6}$.

100 kc sine wave source, with a stability of at least $\pm 1 \times 10^{-6}$.

5 mc sine wave source, with a stability of at least $\pm 1 \times 10^{-6}$.

An a-c voltmeter, Hewlett-Packard model 400C or equivalent.

An electronic counter, Hewlett-Packard model 5532A, or equivalent.

An oscilloscope, Tektronix model 545, or equivalent.

A signal generator, General Radio model 1001A, or equivalent.

Adapter board.

b. Universal Input Board Module No. 1 Alignment

(1) Remove the universal input board and insert the adapter board in the unit. Plug the universal board into the adapter.

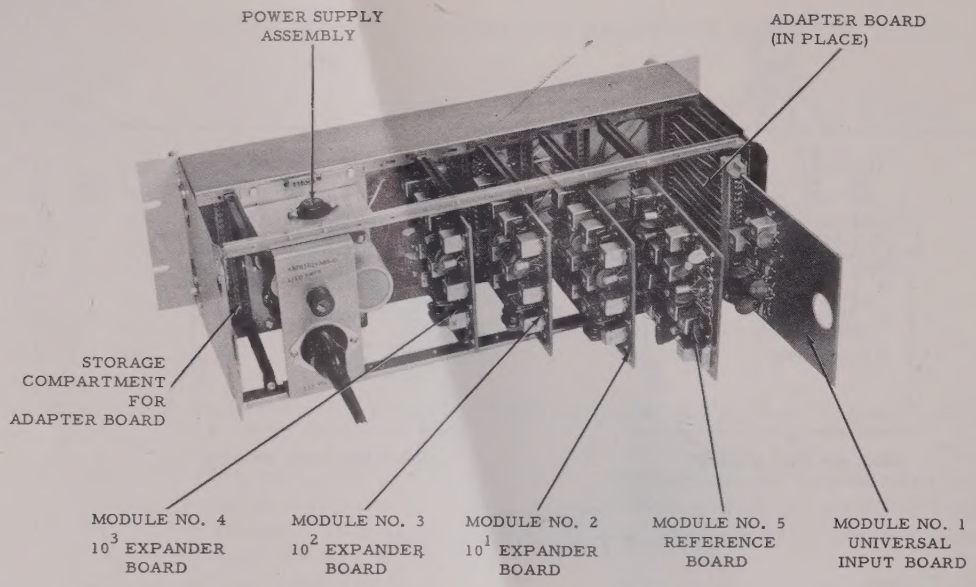

POWER SUPPLY ASSEMBLY
ADAPTER BOARD (IN PLACE)
STORAGE COMPARTMENT FOR ADAPTER BOARD
MODULE NO. 4 10^3 EXPANDER BOARD
MODULE NO. 3 10^2 EXPANDER BOARD
MODULE NO. 2 10^1 EXPANDER BOARD
MODULE NO. 5 REFERENCE BOARD
MODULE NO. 1 UNIVERSAL INPUT BOARD

Figure 3.
Location of Reference Board Modules

(2) Connect a 1 mc input test signal to the input connector.

(3) Disconnect the jumper from the pair of turret terminals located at the top center of the board.

(4) Connect the unit to the power line and place the power switch in the ON position.

(5) Connect the horizontal input of the scope to plug #3 of the universal board.

(6) Connect the vertical input of the scope to the emitter of Q4.

(7) Adjust L21 for a 2:1 pattern on the scope screen.

(8) Connect alignment jumper of Q5.

(9) Connect the vertical input of the scope to pin #17 of the plug.

(10) Adjust L22 for a 1:1 pattern on the scope screen.

(11) Connect a 100 kc signal to input connector.

(12) Re-connect the vertical input of the scope to the emitter of Q4.

(13) Re-adjust L21 for a locked pattern of 5:1.

(14) Remove 100 kc input signal and replace with a 5 mc signal.

(15) Connect the vertical input of the scope to pin #17 of the plug.

(16) Re-adjust L22 until a 5:1 lock pattern is obtained on the scope.

(17) This completes alignment of the universal input board.

c. Reference Board Module No. 5 Alignment

NOTE

It is recommended that a low capacitance probe (10 uuf or less) be used for connection to the module. During the reference board alignment, all other boards must be in the unit.

(1) Remove reference board and insert adapter board in unit. Plug reference board into adapter board.

(2) Connect 1 mc reference signal to unit.

(3) Connect reference out (1 mc) to signal in.

(4) Connect indication equipment as shown in figure 4.

(5) Connect probe to terminals 1 and 2 of coil L1. Short circuit L2 (C5, C6) and tune L1 for maximum at 1 mc. Remove short from L2.

(6) Connect probe across open circuit secondary of L2, and tune L2 for maximum at 1 mc.

(7) Connect probe to secondary of L7 and tune L7 for maximum at 1 mc.

(8) Remove 1 mc signal from signal input. Connect probe to the secondary of L8. Short coil L4. Apply the 100 kc signal via a 1K resistor, in series with 0.1 uf capacitor, to the base of Q2. Tune L3 and L8 for maximum at 100 kc. Remove short from L4.

(9) Leave the 100 kc signal connected, as in (8). Connect the probe across C18, tune L4 and L5 for maximum at 900 kc. Remove the 100 kc signal.

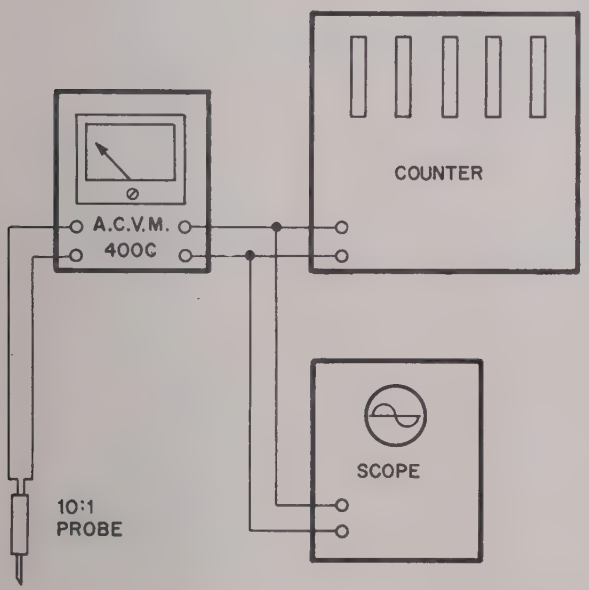


Figure 4.
Alignment Indication Equipment
Block Diagram

(10) Reconnect the 1 mc signal, as in 2A2. With the probe still connected across C18, retune L4 and L5 for maximum at 900 kc.

(11) Connect probe across one secondary of L6, tune L6 for maximum at 900 kc. Check second secondary for output at 900 kc.

(12) Connect probe across one secondary of L9, tune L9 for maximum at 900 kc. Check second secondary for output at 900 kc.

(13) Recheck L8 secondary for output at 100 kc.

(14) This completes the alignment of the reference module.

(15) Remove adapter board and refit reference board in unit.

d. Error Expander Board
Module No. 2 Alignment

(1) Remove expander board and insert adapter board in unit. Plug expander board into adapter board.

(2) Connect probe across L10, short C34, tune L10 for maximum at 1 mc. Remove short from C34.

(3) Connect probe to anode of CR1, short C39, tune L11 for maximum at 1 mc.

(4) Connect probe across C37, tune L12 for maximum at 900 kc. Remove short from C39.

(5) Connect probe to anode of CR1, short C34, tune L13 for maximum at 900 kc. Remove short from C34.

(6) Connect probe across secondary of L14 short C44, tune L14 for maximum at 100 kc. Remove short from C44.

(7) Connect probe across secondary of L15 and tune L15 for maximum at 100 kc.

(8) Connect probe across C47, short C49, tune L16 for maximum at 500 kc. Remove short from C49.

(9) Connect probe across secondary of L17 and tune for maximum at 500 kc.

(10) Connect probe across C52, short C54, tune L18 for maximum at 1 mc. Remove short from C54.

(11) Connect probe across secondary of L19 and tune L19 for maximum at 1 mc.

(12) This completes the alignment of Module No. 2.

(13) Expander board modules number 3 and 4 are aligned in a similar manner.

e. Bandwidth Measurement

(1) Connect signal generator to 1 mc input. Set generator frequency to 1 mc and output level to 0.3 v rms.

(2) Remove probe from a-c voltmeter (fig. 4). Connect voltmeter input to 10^1 expanded output using short length of coax cable (RG-58A). Leave counter connected to voltmeter output. Note voltmeter reading.

(3) Vary signal generator frequency above 1 mc until meter reading is 3 db below reading of step (2). Record frequency.

(4) Vary signal generator frequency below 1 mc until meter reading is 3 db below reading of step (2). Record frequency.

(5) The first expanded output bandwidth is then the frequency of step (3) minus the frequency of step (4), and should be no less than 1 mc ±12 kc.

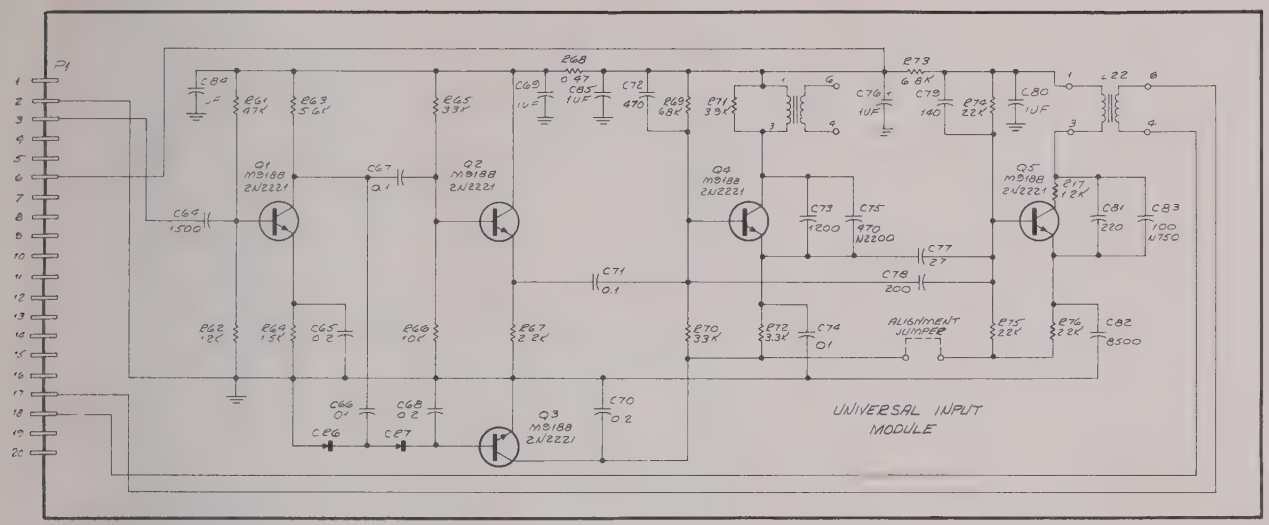
(6) Connect the signal generator to expanded output 10^1 and a-c voltmeter to expanded output 10^2. Set generator frequency to 1 mc and output level to 0.3 v rms.

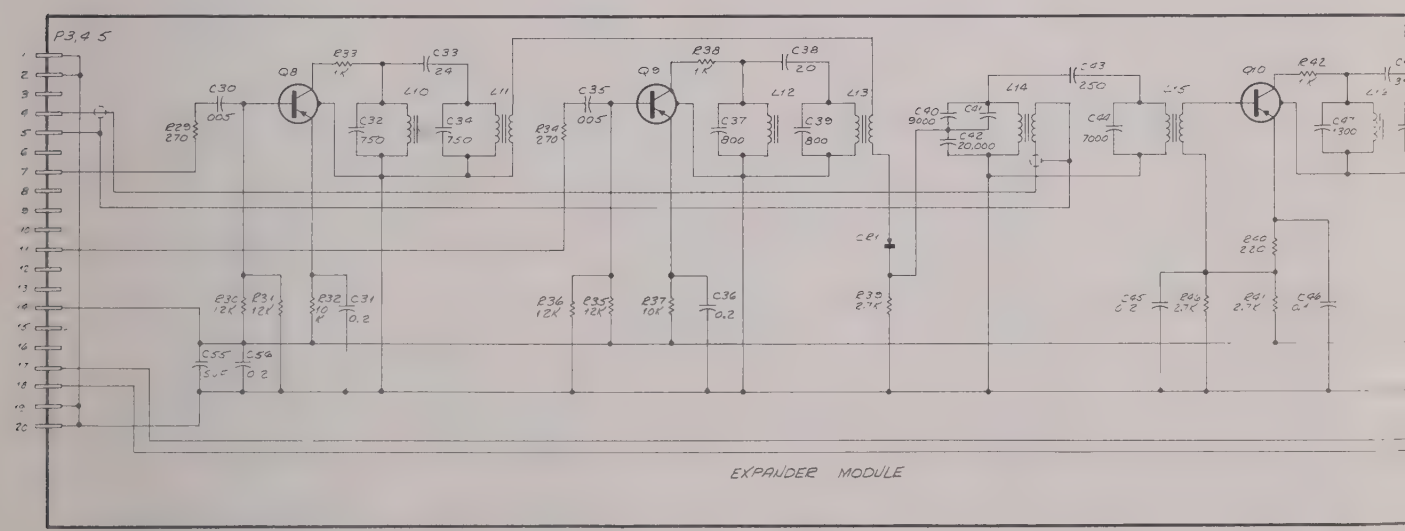
(7) Repeat steps (3), (4), and (5).

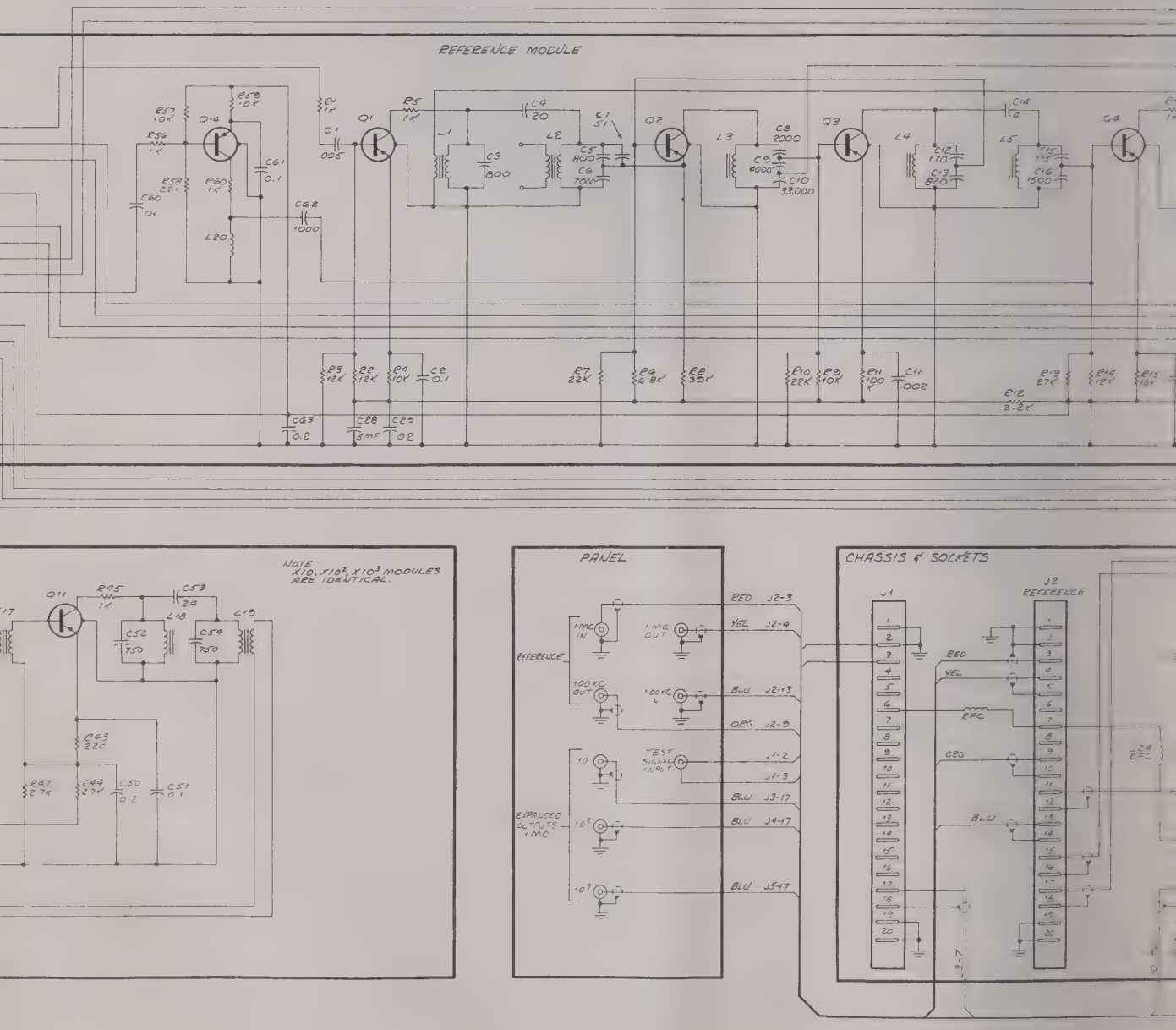
(8) This gives the expanded output bandwidth of 10^2 module.

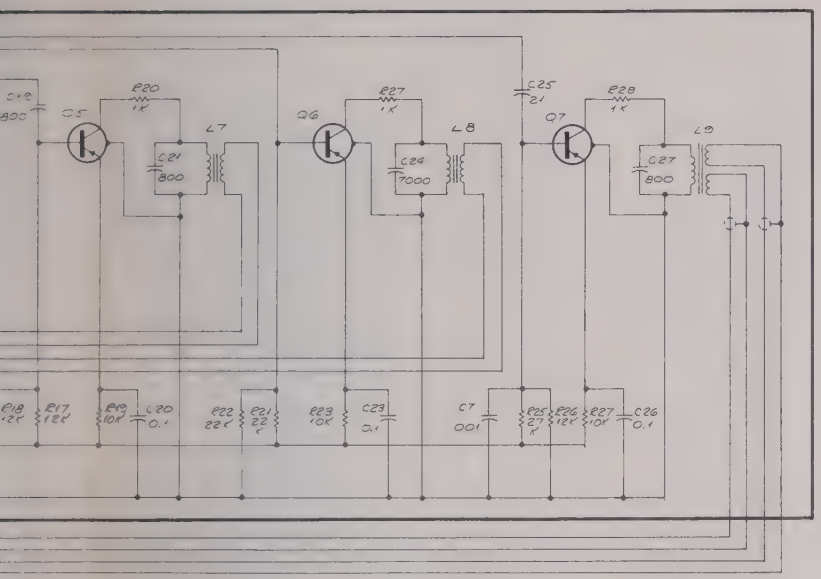
(9) Similarly the 10^3 expanded output is checked using expanded output 10^2 as input and connecting the a-c voltmeter to output 10^3.

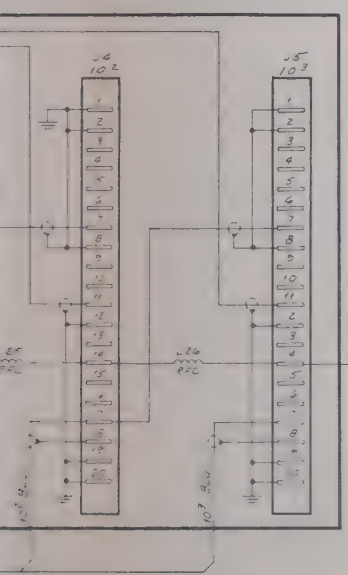
(10) This concludes the alignment of the complete unit.


P1
C60
R61 47K
R63 5.6K
R65 33K
R68 0.47
C69 1UF
C85 1UF
C72 470
R69 68K
R71 3.9K
C76 1UF
R73 6.8K
C79 140
R74 22K
C80 1UF
L22
Q1 M9188 2N2221
Q2 M9188 2N2221
Q4 M9188 2N2221
Q5 M9188 2N2221
C67 0.1
C64 1500
R17 1.2K
C81 220
C83 100 W150
C73 1200
C75 470 W200
C77 27
C71 0.1
C78 200
R62 12K
R64 15K
C65 0.2
R66 10K
R67 2.2K
R70 3.3K
R72 3.3K
C74 .01
ALIGNMENT JUMPER
R75 22K
R76 22K
C82 8500
C66 0.1
C68 0.2
C70 0.2
C86
C87
Q3 M9188 2N2221
UNIVERSAL INPUT MODULE


P3,4,5
Q8
Q9
Q10
R33 1K
C33 24
C30 .005
L10
L11
C32 750
C34 750
R29 270
C35 .005
R38 1K
C38 20
L12
L13
C37 800
C39 800
R34 270
C90 9000
C91
C92 20,000
L14
C93 250
L15
C94 7000
R82 1K
C97 1300
L16
R80 220
C81
R30 12K
R31 12K
R32 10K
C31 0.2
C55 3.0F
C54 0.2
R36 12K
C35 12K
R37 10K
C36 0.2
R35 2.7K
C95 0.2
R84 2.7K
R81 2.7K
C96 0.1
EXPANDER MODULE


REFERENCE MODULE
Q1
Q2
Q3
Q4
Q11
L1
L2
L3
L4
L5
L18
L19
L20
C1 .005
C2 0.1
C3 800
C4 20
C5 800
C6 7000
C7 5-1
C8 2000
C9 4000
C10 33,000
C11 .002
C12 170
C13 820
C14 a
C15 175
C16 1500
C28 5MF
C29 .02
C50 .02
C51 0.1
C52 750
C53 24
C54 750
C60 .01
C61 0.1
C62 1000
C63 0.2
R1 1K
R2 12K
R3 12K
R4 10K
R5 1K
R7 22K
R8 35K
R9 10K
R10 22K
R11 100
R12 2.2K
R13 27K
R14 12K
R15 10K
R47 27K
R48 27K
R50 10K
R56 1K
R57 10K
R58 82Ω
R60 1K
R95 1K
R103 220
NOTE: X10, X10² X10³ MODULES ARE IDENTICAL.
PANEL
REFERENCE
1MC IN
1MC OUT
100KC OUT
100KC
TEST SIGNAL INPUT
10
EXPANDED OUTPUTS 1MC
RED J2-3
YEL J2-4
BLU J2-13
ORG J2-9
J1-2
J1-3
BLU J3-17
BLU J4-17
BLU J5-17
CHASSIS & SOCKETS
J1
J2 REFERENCE
RED
YEL
RFC
ORG
BLU





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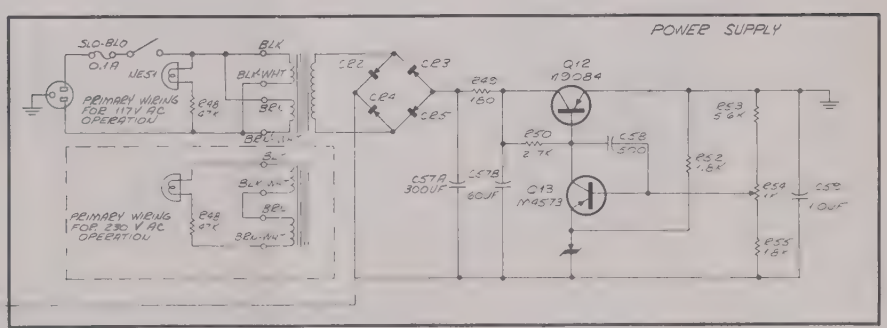


Model S1061BR Frequency Error Expander
Schematic Diagram
Motorola No. 63E81027A03-O
6/25/65-UP

TABLE 1.

EXAMPLES OF OUTPUT VS FREQUENCY INPUTS

FREQUENCY (INPUT)	OUTPUT OF ERROR EXPANDER 10	10^2	10^3	$\frac{\Delta F}{F}$ (IN X10POS)	ABSOLUTE ERROR
100,000.01 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.01 cps
250,000.025 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.025 cps
500,000.05 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.05 cps
1,000,000.10 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.10 cps
2,000,000.20 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.20 cps
3,000,000.30 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.30 cps
4,000,000.40 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.40 cps
5,000,000.50 cps	1,000,001	1,000,010	1,000,100	$1X10^7$	.50 cps

In 10^2 position error resolution is 1×10^{-8}, similarly in the 10^3 position error resolution is 1×10^{-9}.

mixer and times 9 (X9) multiplier to produce a 900 kc output. The mixer generates a 100 kc signal with a tuned output circuit. This is multiplied nine times, to 900 kc, for use in the expanding circuits as well as being fed back to the mixer to support generation of a 100 kc difference frequency. Buffer amplifiers are employed at the input and output of the mixer to supply a gating signal to an electronic counter.

The test signal is routed to the universal input module where the signal is amplified, isolated and processed to an output frequency of 1 mc.

The universal input module will convert any one of eight standard test signals to 1.0 megacycle for processing through the frequency error expander. The eight test signals are listed in TABLE 1. Interpretation of the electronic count-

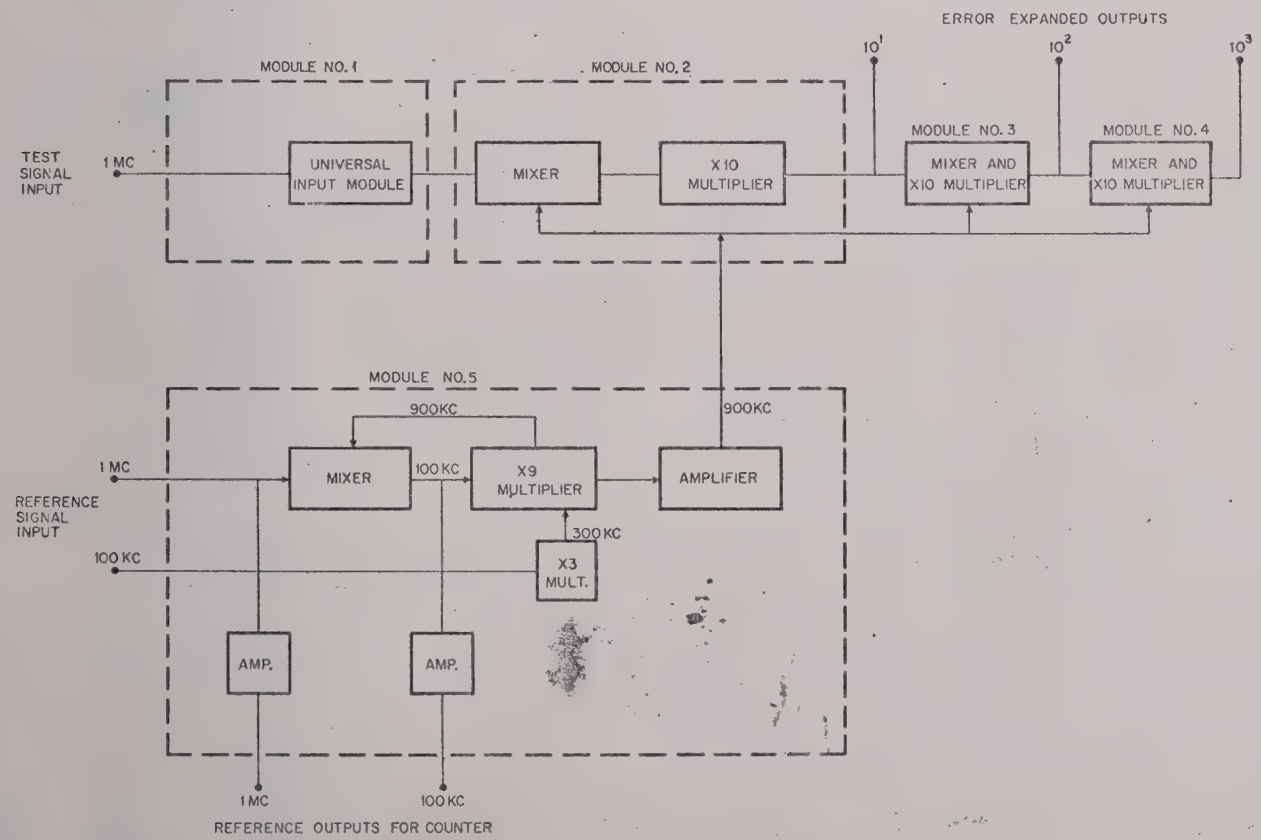
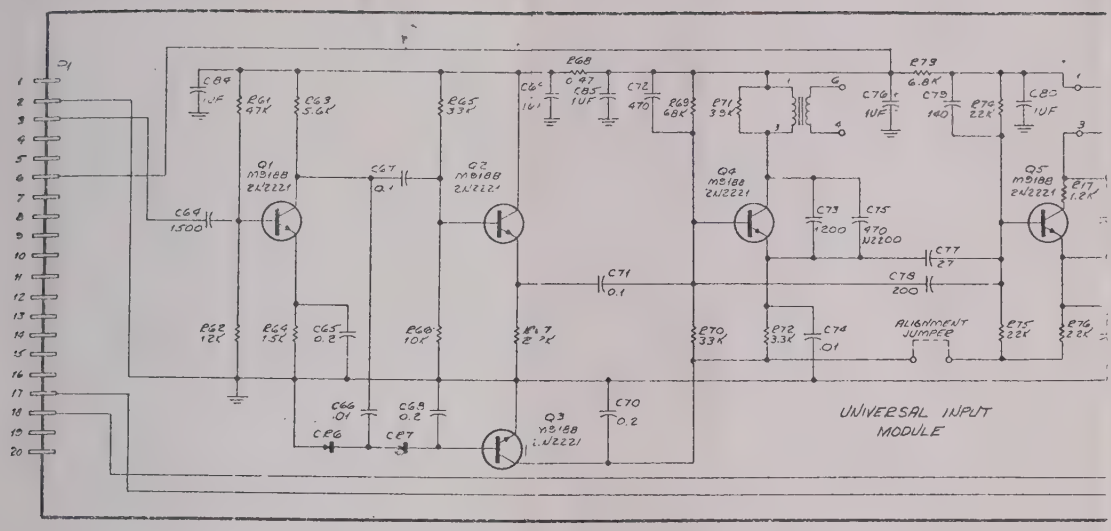
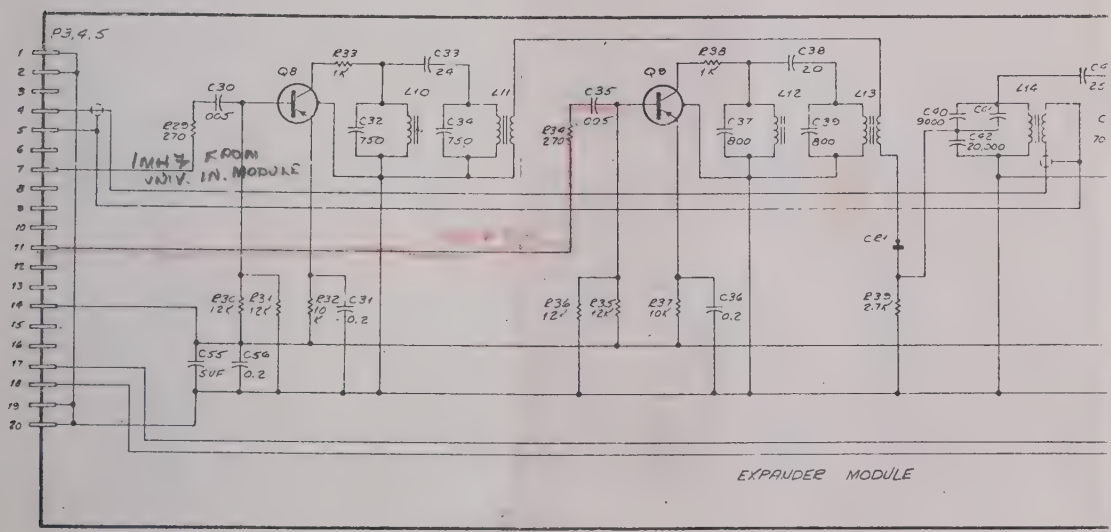
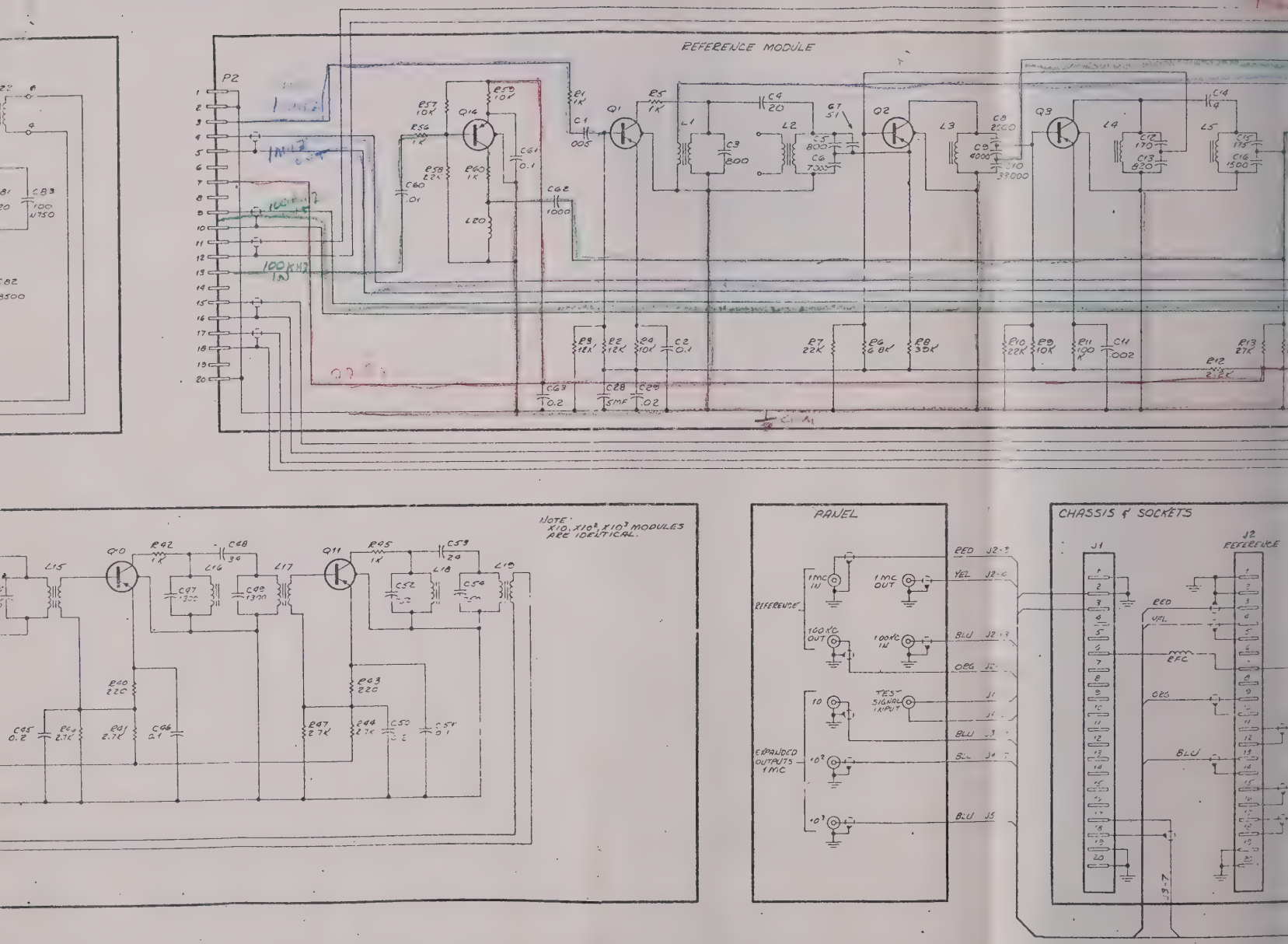


Figure 1.
Frequency Error Expander
Block Diagram

CEPD-8275-A


P1
C64 .1UF
R61 47K
C63 5.6K
R65 33K
R68 0.47
C66 16V
C65 1UF
C72 470
R69 68K
R71 3.9K
C76 1UF
R73 6.8K
C79 140
R76 22K
C83 1UF
Q1 MB188 2N2221
C67 0.1
Q2 MB188 2N2221
Q4 MB188 2N2221
C73 200
C75 470 N2200
Q5 MB188 2N2221
R17 1.2K
C69 1500
C77 27
C78 200
C71 0.1
R62 12K
R64 1.5K
C65 0.2
R66 10K
R67 2.2K
R70 33K
R72 3.3K
C74 .01
ALIGNMENT JUMPER
R75 22K
R76 2.2K
C66 .01
C68 0.2
C70 0.2
CR6
CR7
Q3 MB188 2N2221
UNIVERSAL INPUT MODULE

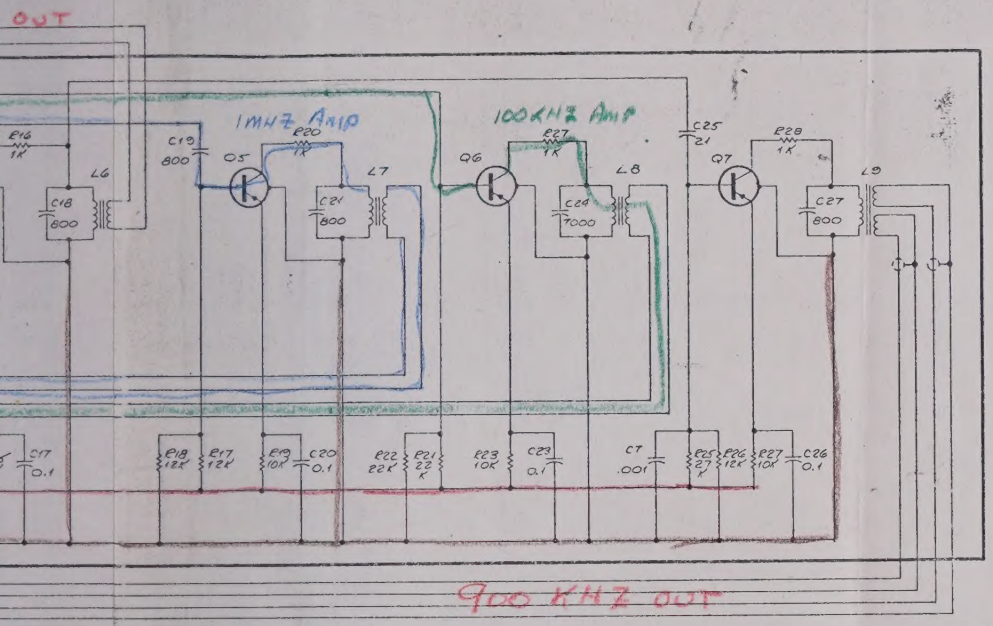

P3,4,5
C30 .005
R29 270
Q8
R33 1K
C33 24
L10
L11
C32 750
C34 750
1MH7 FROM UNIV. IN. MODULE
C35 .005
R36 270
Q8
R38 1K
C38 20
L12
L13
C37 800
C39 800
L14
C40 9000
C41
C42 20,000
CR1
R30 12K
R31 12K
R32 10K
C31 0.2
C55 3UF
C56 0.2
R36 12K
R35 12K
R37 10K
C36 0.2
R39 2.7K
EXPANDER MODULE


REFERENCE MODULE
P2
Q14
Q1
Q2
Q3
L1
L2
L3
L4
L5
100 KHz IN

NOTE:
X10, X10², X10³ MODULES
ARE IDENTICAL.
Q10
Q11
L15
L16
L17
L18
L19

PANEL
1MC IN
1MC OUT
REFERENCE
100KC OUT
100KC IN
10
TEST SIGNAL INPUT
EXPANDED OUTPUTS 1MC
RED J2-7
YEL J2-6
BLU J2-3
ORG J2-
BLU J3
BLU J4
BLU J5

CHASSIS & SOCKETS
J1
J2
REFERENCE
RED
YEL
RFC
ORG
BLU



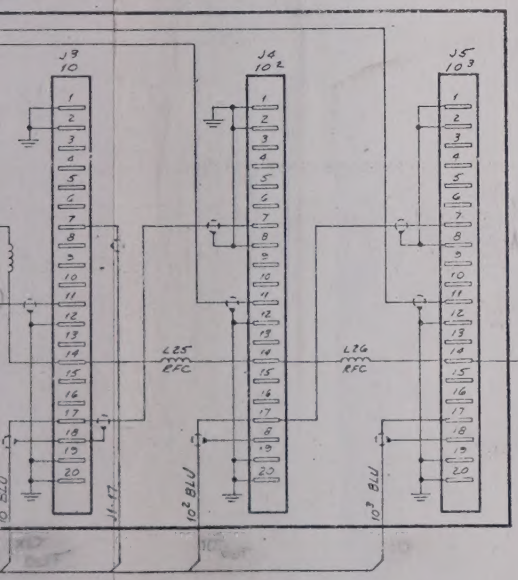
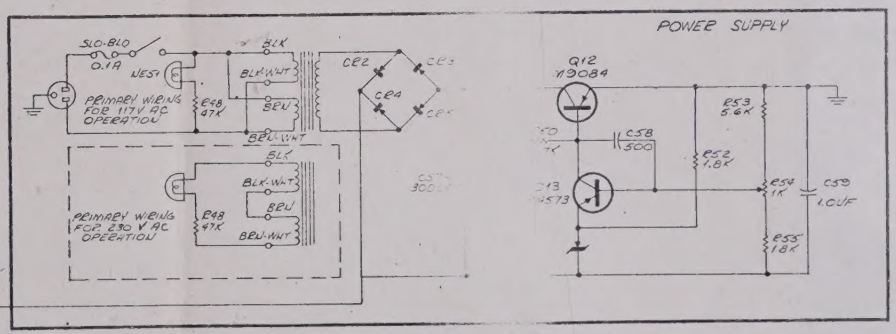
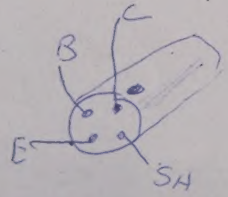


DIAGRAM NO 63E81027A03





Model S10[illegible] Frequency Error Expander
Schematic [illegible]ram
Motorola [illegible]E81027A03-O
6/25/65-[illegible]